

General operation and modes of TEM

Purpose of the practicum: acquiring a hands-on experience in TEM operation, understanding construction of the microscope, alignment procedures, operation in diffraction and imaging modes, acquisition and basic evaluation of the data.

Results to be achieved: setup for the proper imaging conditions (alignment); experimental recording of TEM images and diffractions.

Requested theoretical background

Due to the limited operation time at the microscope, participants are advised to be familiar with the following concepts:

1. Main components and construction of TEM
 - a. Column and functional components (gun, condenser, objective, projector, apertures, detector, sample holder, vacuum system)
<http://www.microscopy.ethz.ch/TEM-structure.htm>
 - b. Ray paths for different imaging modes
2. Imaging modes
 - a. Electron beam interaction with the sample, exit wave
 - b. Thinking in real and reciprocal space
 - c. Lens as Fourier transformer
 - d. Diffraction mode
<http://www.matter.org.uk/diffraction/>
 - i. Information contained in diffraction pattern
 - ii. Concept of crystallographic zone axis
 - e. Imaging mode
<http://www.nanoscience.gatech.edu/zlwang/research/tem.html>
 - i. One beam imaging; bright field (BF) and dark field (DF)
 - ii. Multibeam imaging, lattice images
 - iii. Lens aberrations

Content of the practicum and consequent report

All the steps of practical operation of the instrument will be explained and shown by demonstrator at place. Participants will follow up instructions and obtain their own data for further evaluation. It is advised to have a memory stick for data pick-up.

1. Column alignment

<http://www.rodenburg.org/RODENBURG.pdf>

- a. Gun
- b. Condenser
- c. Stigmation
- d. Optimum defocus

<http://www.umsl.edu/~fraundorfp/epc/>

Report should contain detailed description of alignment procedure with definition of necessity and meaning of each step.

2. Diffraction

- a. Orientation of Si sample into [110] zone
- b. Setup and recording of Selected Area Electron Diffraction (SAED)

Report should contain a description of how to obtain SAED, identification and proof of correct orientation, identification and measurement of different reflections, estimation of the precision of measurements.

3. Imaging

- a. Setup and recording of BF images at different crystal tilts
- b. Setup and recording of DF images at different diffraction conditions

Report should contain a description of setups for BF and DF modes, explanation of crucial prerequisites for obtaining right images. Origin of the contrast on the recorded images should be evaluated and explained.

Sources of general information:

<http://www.rodenburg.org/guide/index.html>

<http://www.matter.org.uk/tem/>

<http://www.unl.edu/CMRAcfem/temoptic.htm>

<http://www.unl.edu/CMRAcfem/glossary.htm>

<http://em-outreach.ucsd.edu/web-course/toc.html>

<http://www.nanoscience.gatech.edu/zlwang/research/tem.html>